Appl. No.: 10/797,650
Amdt. dated: May 15, 2006
Amendment under 37 CFR 1.116 Expedited Procedure
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## Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

## Listing of Claims:

1. (previously presented) A data I/O system comprising:

a plurality of storage devices; and

a controller which controls said storage devices, wherein said controller includes:

a read/write unit, responsive to the subsequent receipt of a read request and a write request, for reading data stored in said storage devices and writing data in said storage devices;

a logical volume management unit configured to map between a logical image of the data storage of a host processor (logical volume) and an actual space in said storage devices;

a volume management unit configured to manage an active primary production volume (P-VOL) and a secondary mirror volume (S-VOL) group including multiple S-VOLs created as mirror images of said primary volume; and

an S-VOL restoring unit configured to restore the data of a first S-VOL belonging to the S-VOL group with the data of a second S-VOL belonging to the S-VOL group depending on the type of an error that happens in the first S-VOL.

2. (currently amended) A data I/O system according to claim 1,

wherein said controller further includes an access management unit configured to render at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL,

wherein said S-VOL restoring unit recovers an S-VOL belonging to the S-VOL group by copying data of the Read-only (RO) S-VOL to said S-VOL as an error happens in said S-VOL.

3. (currently amended) A data I/O system according to claim 1,

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wherein said controller includes an access management unit configured to render at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL,

wherein said S-VOL restoring unit recovers an S-VOL belonging to the S-VOL group by replacing the S-VOL with said Read-only (RO) S-VOL as an error happens in said S-VOL.

4. (currently amended) A data I/O system according to claim 1,

wherein said controller further includes:

an access management unit configured to render at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL; and

a monitoring unit configured to monitor frequencies of accesses to said at least one Read-only (RO) S-VOL[[s]],

wherein said S-VOL restoring unit restores the data of an S-VOL belonging to the S-VOL group by copying the data of said RO S-VOL with the lowest access frequency as an error happens in said S-VOL.

5. (currently amended) A data I/O system according to claim 1,

wherein said controller further includes:

an access management unit configured to render at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL; and

a monitoring unit configured to monitor frequencies of accesses to the at least one Read-only (RO) S-VOL[[s]],

wherein said S-VOL restoring unit recovers an S-VOL belonging to the S-VOL group by replacing the S-VOL with said RO S-VOL with the lowest access frequency as an error happens in said S-VOL.

6. (currently amended) A data I/O system according to claim 1,

wherein said controller further includes:

an access management unit configured to render at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL and

rendering at least one of said S-VOLs belonging to [[the]] an S-VOL group read-and-writable as at least one Read-and-Writable (RW) S-VOL; and

an increments management unit configured to store updates that have occurred in a Read-and-Writable (RW) S-VOL since a P-VOL and the RW S-VOL were separated in an increments-volume,

wherein said S-VOL restoring unit recovers a RW S-VOL belonging to the S-VOL group by replacing the RW S-VOL with the at least one Read-only (RO) [[RO]] S-VOL that has been updated by data of the increments-volume of the RW S-VOL as an error happens in the RW S-VOL.

7.      (currently amended)  A data I/O system according to claim 1,

wherein said controller further includes:

an access management unit configured to render at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL and rendering at least one of said S-VOLs belonging to [[the]] an S-VOL group read-and-writable as at least one Read-and-Writable (RW) S-VOL;

a monitoring unit configured to monitor frequencies accesses to the at least one Read-only (RO) S-VOL[[s]]; and

an increments management unit configured to store updates that have occurred in a Read-and-Writable (RW) S-VOL since a P-VOL and the RW S-VOL were separated in an increments-volume,

wherein said S-VOL restoring unit recovers a RW S-VOL belonging to the S-VOL group by replacing the RW S-VOL with the RO S-VOL with the lowest access frequency that has updated by data of the increments-volume of the RW S-VOL as an error happens in the RW S-VOL.

8.      (previously presented)  A data I/O system according to claim 7,

wherein said controller further includes a spare SVOL management unit configured to manage a spare S-VOL created as a mirror image of a S-VOL belonging to the S-VOL group and to which read/write accesses are forbidden,

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wherein said S-VOL restoring unit recovers the S-VOL where an error has happened by using said spare S-VOL instead of said RO S-VOL.

9.      (original)  A data I/O system according to claim 7 further comprising a plurality of the storage devices,

wherein said S-VOL restoring unit replaces a storage device where a hardware error has happened and forms an S-VOL with another hardware device.

10.      (original)  A data I/O system according to claim 8 further comprising a plurality of the storage devices,

wherein said S-VOL restoring unit replaces a storage device where a hardware error has happened and forms an S-VOL with another hardware device.

11.      (original)  A data I/O system according to claim 1,

wherein said storage devices are disk drives,

wherein said controller further includes a communication adapter communicating with a data processing system issuing read and write requests.

12.      (previously presented)  A method of controlling a data I/O system which includes:

a plurality of storage devices;

a read/write unit, responsive to the subsequent receipt of a read request and a write request, for reading data stored in said storage devices and writing data in said storage devices; and

a logical volume management unit configured to map between a logical image of the data storage of a host processor (logical volume) and an actual space in said storage devices;

said method comprising:

managing an active primary production volume (PVOL) and a secondary mirror volume (S-VOL) group including multiple S-VOLs created as mirror images of said primary volume; and

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restoring the data of a first S-VOL belonging to the S-VOL group with the data of a second S-VOL belonging to the S-VOL group depending on the type of an error that happens in the first S-VOL.

13.     (currently amended) A method according to claim 12, further comprising:

rendering at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL,

recovering an S-VOL belonging to the S-VOL group by copying data of the at least one Read-only (RO) S-VOL to said S-VOL as an error happens in said S-VOL.

14.     (previously presented) A method according to claim 12, further comprising:

rendering at least one of said S-VOLs read-only,

recovering an S-VOL where a drive error has happened by replacing the S-VOL with said RO S-VOL.

15.     (currently amended) A method according to claim 12, further comprising:

rendering at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL; and

monitoring frequencies of accesses to said at least one Read-only (RO) S-VOL[[s]],

restoring the data of an S-VOL belonging to the S-VOL group by copying the data of said RO S-VOL with the lowest access frequency as an error happens in said S-VOL.

16.     (currently amended) A method according to claim 12, further comprising:

rendering at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL; and

monitoring frequencies of accesses to the at least one Read-only (RO) [[RO]] S-VOL[[s]],

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recovering an S-VOL belonging to the S-VOL group by replacing the S-VOL with a RO S-VOL with the lowest access frequency as an error happens in said S-VOL.

17.    (currently amended)  A method according to claim 12, further comprising:

rendering at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL and rendering at least one of said S-VOLs belonging to [[the]] an S-VOL group read-and-writable as at least one Read-and-Writable (RW) S-VOL; and

storing updates that have occurred in a Read-and-Writable (RW) S-VOL since a P-VOL and the RW S-VOL were separated in an increments-volume,

recovering a RW S-VOL belonging to the S-VOL group by replacing the SW S-VOL with the at least one Read-only (RO) S-VOL that has been updated by data of the increments-volume of the RW S-VOL as an error happens in the RW S-VOL.

18.    (currently amended)  A method according to claim 12, further comprising:

rendering at least one of said S-VOLs belonging to [[the]] an S-VOL group read-only as at least one Read-only (RO) S-VOL and rendering at least one of said S-VOLs belonging to the S-VOL group read-and-writable;

monitoring frequencies accesses to the at least one Read-only (RO) S-VOL[[s]]; and

storing updates that have occurred in a RW S-VOL since a P-VOL and the RW S-VOL were separated in an increments-volume,

recovering a RW S-VOL belonging to the S-VOL group by replacing the RW S-VOL with the RO S-VOL with the lowest access frequency that has updated by data of the increments-volume of the RW S-VOL as an error happens in the RW S-VOL.

19.    (previously presented)  A method according to claim 18, further comprising:

managing a spare S-VOL created as a mirror image of a S-VOL belonging to the S-VOL group and to which read/write accesses are forbidden,

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recovering the S-VOL where an error has happened by using said spare S-VOL instead of said RO S-VOL.

20.     (previously presented)  A method according to claim 18, further comprising:

replacing a storage device where a hardware error has happened and forms an S-VOL with another hardware device.